Part-4-Model-Based

December 21, 2021

```
[ ]: import pandas as pd
     import numpy as np
     pd.set_option('max_rows', 15)
     pd.plotting.register_matplotlib_converters()
     import matplotlib.pyplot as plt
     %matplotlib inline
     import seaborn as sns
     from sklearn.metrics import mean_absolute_error
     from sklearn.model_selection import train_test_split
     from sklearn.tree import DecisionTreeRegressor
```

```
[ ]: # Load merged data
     mergeddata = pd.read_csv('mergeddata.csv', index_col = 0)
     mergeddata.head()
```

```
C:\Users\pmogh\anaconda3\lib\site-
packages\IPython\core\interactiveshell.py:3185: DtypeWarning: Columns (14) have
mixed types.Specify dtype option on import or set low_memory=False.
  has_raised = await self.run_ast_nodes(code_ast.body, cell_name,
```

```
[ ]:    uid  id  owned publisher      genres        app_name           title  \
     0    0  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     1    1  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     2    3  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     3    4  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     4   10  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike

                                                   url release_date  \
     0  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     1  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     2  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     3  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     4  http://store.steampowered.com/app/10/CounterSt…   2000-11-01

                                                   tags  discount_price  \
     0  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…             NaN
     1  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…             NaN
     2  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…             NaN
```

```
3  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…             NaN
4  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…             NaN

                                         reviews_url  \
0  http://steamcommunity.com/app/10/reviews/?brow…
1  http://steamcommunity.com/app/10/reviews/?brow…
2  http://steamcommunity.com/app/10/reviews/?brow…
3  http://steamcommunity.com/app/10/reviews/?brow…
4  http://steamcommunity.com/app/10/reviews/?brow…

                                          specs price  early_access developer  \
0  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
1  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
2  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
3  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
4  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve

                sentiment  metascore
0  Overwhelmingly Positive       88.0
1  Overwhelmingly Positive       88.0
2  Overwhelmingly Positive       88.0
3  Overwhelmingly Positive       88.0
4  Overwhelmingly Positive       88.0
```

```
[ ]: mergeddata.shape
```

```
[ ]: (819988, 18)
```

```
[ ]: mergeddata.describe()
```

```
[ ]:                  uid             id     owned  discount_price      metascore
     count  819988.000000  819988.000000  819988.0     1052.000000  485063.000000
     mean     5090.851825  185177.375136       1.0        0.637405      78.504638
     std      2858.808048  135141.482185       0.0        0.698054       9.801869
     min         0.000000      10.000000       1.0        0.490000      20.000000
     25%      2641.000000   34900.000000       1.0        0.490000      73.000000
     50%      5121.000000  218820.000000       1.0        0.490000      80.000000
     75%      7546.000000  287290.000000       1.0        0.490000      85.000000
     max      9999.000000  530720.000000       1.0        7.490000      96.000000
```

```
[ ]: mergeddata.describe(include="object")
```

```
[ ]:       publisher      genres                          app_name  \
     count     806910      816219                            819988
     unique      3747         569                              8169
     top        Valve  ['Action']  Counter-Strike: Global Offensive
     freq       58250      145396                              6966
```

```
                                   title  \
count                             819988
unique                              8169
top     Counter-Strike: Global Offensive
freq                                6966

                                                      url release_date  \
count                                              819988       818866
unique                                               8171         2621
top     http://store.steampowered.com/app/730/CounterS…   2012-08-21
freq                                                 6966         7086

                                                     tags  \
count                                              819971
unique                                               7125
top     ['FPS', 'Multiplayer', 'Shooter', 'Action', 'T…
freq                                                 6966

                                              reviews_url              specs  \
count                                              819988             816228
unique                                               8171               1563
top     http://steamcommunity.com/app/730/reviews/?bro…  ['Single-player']
freq                                                 6966              68096

         price developer      sentiment
count   804282    812896         819639
unique     104      5228             18
top       9.99     Valve  Very Positive
freq    136063     49265         410388
```

1 Find the count of Numeric column and Categorical Column

[ ]:
```
print(f"Find the count of Numeric Column : {len(mergeddata.
 ↪select_dtypes(include=np.number).columns)}")

print(f"Numeric Column Name : {mergeddata.select_dtypes(include=np.number).
 ↪columns.tolist}")
```

```
Find the count of Numeric Column : 5
Numeric Column Name : <bound method IndexOpsMixin.tolist of Index(['uid', 'id',
'owned', 'discount_price', 'metascore'], dtype='object')>
```

[ ]:
```
print(f"Find the count of Categorical Column : {len(mergeddata.
 ↪select_dtypes(exclude=np.number).columns)}")
```

```
print(f"Categorical Column Name : {mergeddata.select_dtypes(exclude=np.number).
 ↪columns.tolist}")
```

```
Find the count of Categorical Column : 13
Categorical Column Name : <bound method IndexOpsMixin.tolist of
Index(['publisher', 'genres', 'app_name', 'title', 'url', 'release_date',
       'tags', 'reviews_url', 'specs', 'price', 'early_access', 'developer',
       'sentiment'],
      dtype='object')>
```

[ ]:
```
mergeddata.isnull().sum().sort_values(ascending=False).head(15)
```

[ ]:
```
discount_price    818936
metascore         334925
price              15706
publisher          13078
developer           7092
genres              3769
specs               3760
release_date        1122
sentiment            349
tags                  17
id                     0
reviews_url            0
url                    0
title                  0
early_access           0
dtype: int64
```

2 Find total null values in data and percentage of null values in each columns

[ ]:
```
def find_total_perc_missing (data_set):
    temp_missing_val = (data_set.isnull().sum()).sum()
    total_cel = np.product(data_set.shape)
    perc_missing_data=100 * (temp_missing_val/total_cel)
    return perc_missing_data
```

[ ]:
```
print(find_total_perc_missing(mergeddata))
```

```
8.121758421396953
```

[ ]:
```
def find_missing_value(data_set):
    percent_missing = data_set.isnull().sum() * 100 / len(data_set)
    missing_value_df = pd.DataFrame({'column_name': data_set.
 ↪columns,'percent_missing': percent_missing})
```

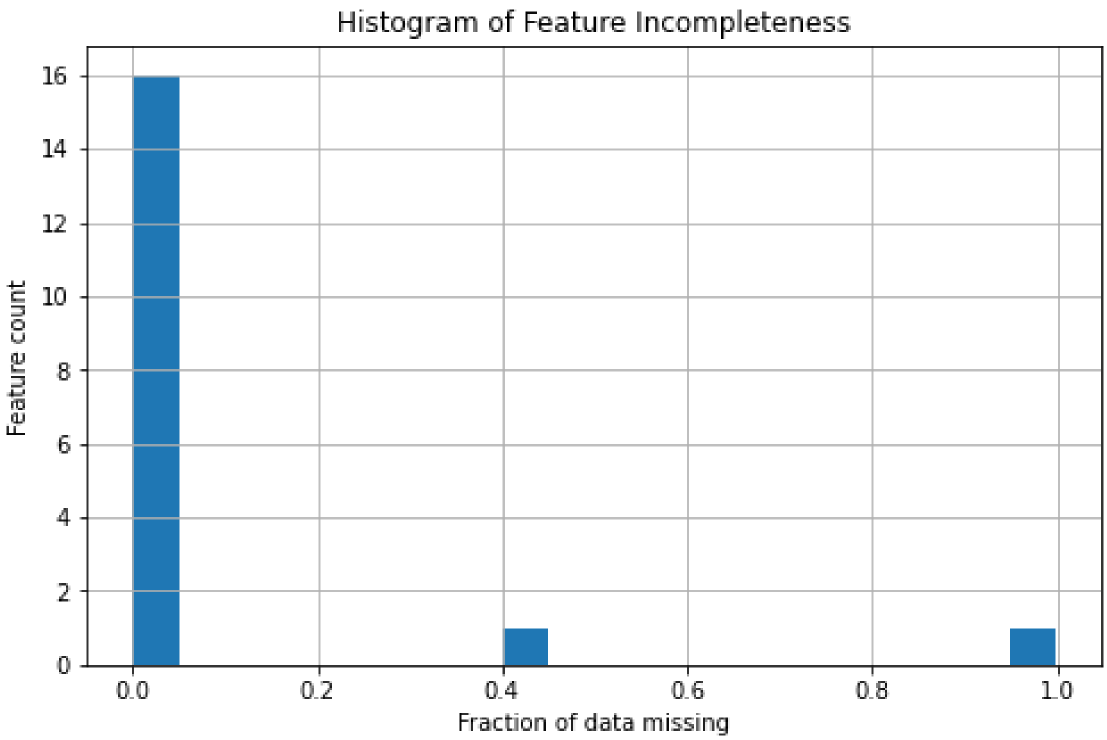
```
    missing_value_df=missing_value_df.sort_values('percent_missing',␣
↪ascending=False)

    return missing_value_df
```

[ ]:
```
find_missing_value(mergeddata).head(15)
```

[ ]:
```
                  column_name  percent_missing
discount_price  discount_price        99.871705
metascore            metascore        40.845110
price                    price         1.915394
publisher            publisher         1.594901
developer            developer         0.864891
genres                  genres         0.459641
specs                    specs         0.458543
release_date      release_date         0.136831
sentiment            sentiment         0.042562
tags                      tags         0.002073
id                          id         0.000000
reviews_url        reviews_url         0.000000
url                        url         0.000000
title                    title         0.000000
early_access      early_access         0.000000
```

[ ]:
```
plt.figure(figsize=(8,5))
(mergeddata.isna().sum() / mergeddata.shape[0]).hist(bins=20)
plt.title('Histogram of Feature Incompleteness')
plt.xlabel('Fraction of data missing')
plt.ylabel('Feature count');
```



[ ]:

```
def remove_columns (data_set,final_val_data):
    list_remove_column=[]
    for index,row in final_val_data.iterrows():
        if row['percent_missing'] > 60:
            if index in mergeddata.columns:
                list_remove_column.append(index)
    return list_remove_column
```

3 Remove the column with more than 50% null values

[ ]:

```
# calling the above function to find the list of above 60
Removed_Column_Name=remove_columns(mergeddata,find_missing_value(mergeddata))
mergeddata=mergeddata.drop(Removed_Column_Name, axis=1)
```

[ ]:

```
find_missing_value(mergeddata).head(15)
```

[ ]:

```
               column_name  percent_missing
metascore        metascore        40.845110
price                price         1.915394
publisher        publisher         1.594901
developer        developer         0.864891
genres              genres         0.459641
```

```
specs                 specs         0.458543
release_date   release_date         0.136831
sentiment         sentiment         0.042562
tags                   tags         0.002073
url                     url         0.000000
id                       id         0.000000
reviews_url     reviews_url         0.000000
title                 title         0.000000
app_name           app_name         0.000000
early_access   early_access         0.000000
```

Now check the shape of the dataset

```
[ ]: print('Merge Data',mergeddata.isnull().all(axis=0).sum())
```

```
Merge Data 0
```

```
[ ]: print("Merge Data",len(mergeddata[mergeddata.isnull().sum(axis=1)>14].index))
```

```
Merge Data 0
```

```
[ ]: type(mergeddata.release_date)
```

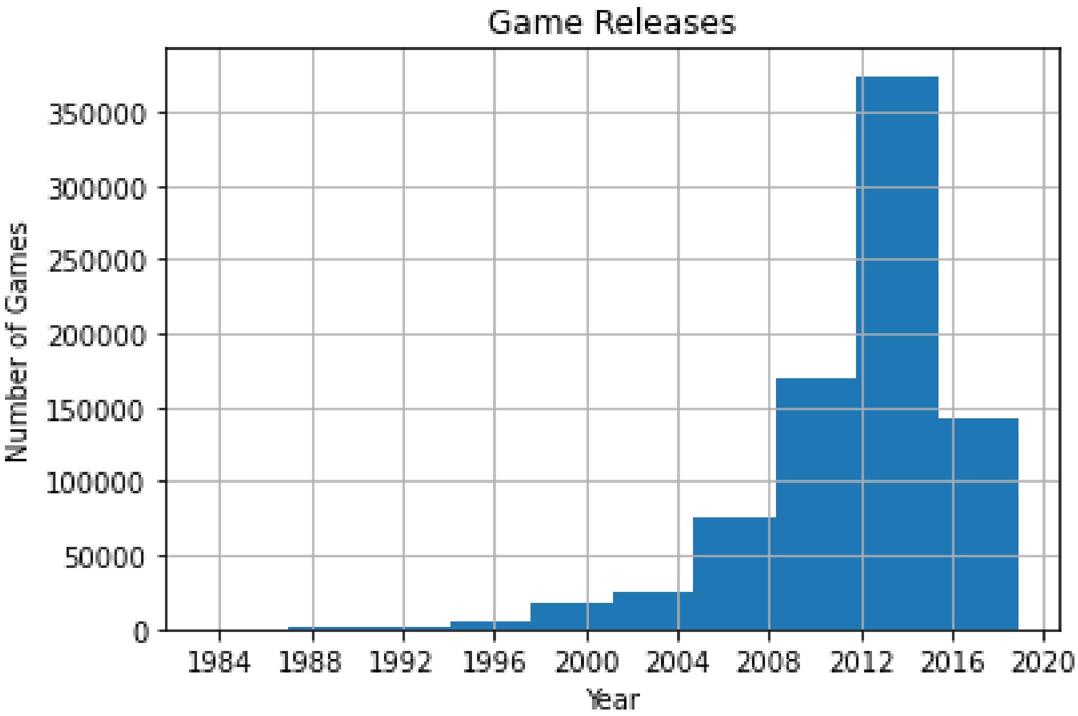
```
[ ]: pandas.core.series.Series
```

Feature engineer the date into year and months

```
[ ]: mergeddata['release_date'] = pd.to_datetime(pd.
      ↪to_datetime(mergeddata['release_date'], errors='coerce', format='%Y-%m-%d'))
```

```
[ ]: mergeddata['release_date_year']=mergeddata['release_date'].dt.year
     mergeddata['release_date_month']=mergeddata['release_date'].dt.month
```

```
[ ]: # Plot histogram of release date feat
     mergeddata['release_date'].hist()
     plt.title('Game Releases')
     plt.ylabel('Number of Games')
     plt.xlabel('Year')
     plt.show()
```



```
[ ]: mergeddata.shape
```

```
[ ]: (819988, 19)
```

```
[ ]: mergeddata.sentiment.value_counts()
```

```
[ ]: Very Positive              410388
     Overwhelmingly Positive    133583
     Mixed                      124518
     Mostly Positive            118654
     Mostly Negative             13260
                                  …
     5 user reviews                682
     3 user reviews                646
     9 user reviews                608
     Overwhelmingly Negative       539
     1 user reviews                523
     Name: sentiment, Length: 18, dtype: int64
```

```
[ ]: mergeddata.sentiment.unique()
```

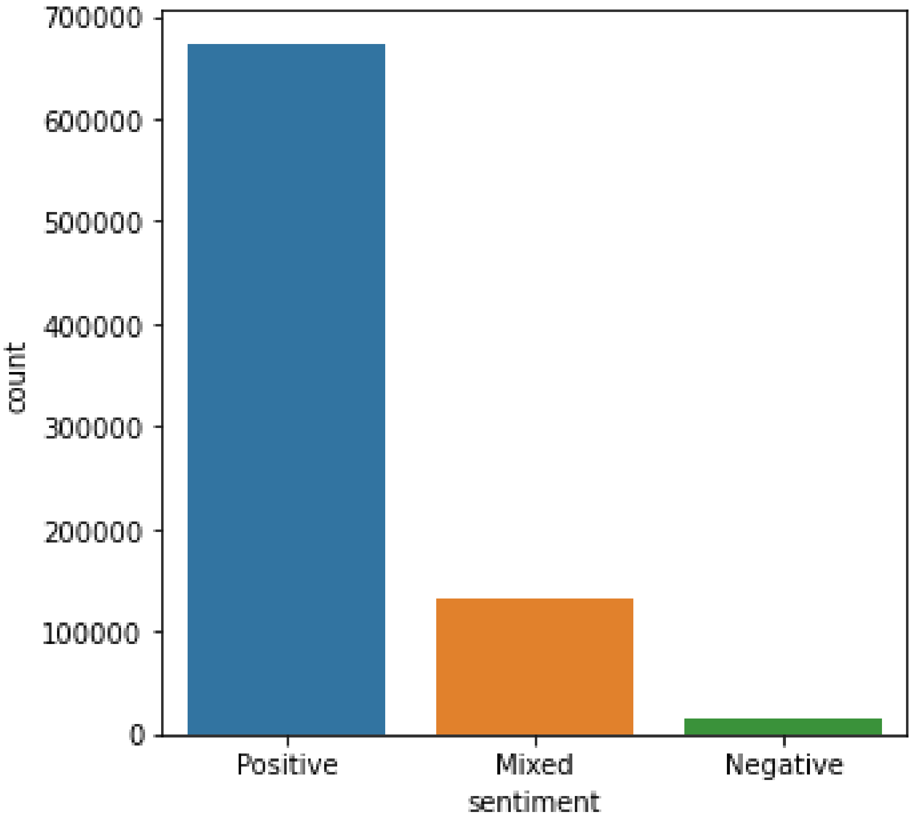
```
[ ]: array(['Overwhelmingly Positive', 'Very Positive', 'Mostly Positive',
            'Mixed', 'Mostly Negative', 'Overwhelmingly Negative', 'Positive',
            '2 user reviews', '8 user reviews', '5 user reviews',
            '7 user reviews', '6 user reviews', 'Very Negative',
            '3 user reviews', 'Negative', '4 user reviews', '1 user reviews',
            '9 user reviews', nan], dtype=object)
```

[ ]:

```
mergeddata['sentiment']=mergeddata['sentiment'].replace(['Overwhelmingly␣
 ↪Positive','Very Positive','Mostly Positive', 'Positive'],'Positive')
mergeddata['sentiment']=mergeddata['sentiment'].replace(['Overwhelmingly␣
 ↪Negative','Very Negative','Mostly Negative', 'Negative'],'Negative')
mergeddata['sentiment']=mergeddata['sentiment'].replace(['1 user reviews','2␣
 ↪user reviews','3 user reviews', '4 user reviews','5 user reviews','6 user␣
 ↪reviews','7 user reviews', '8 user reviews','9 user reviews'],'Mixed')
```

[ ]:

```
plt.figure(figsize=(5,5))
sns.countplot(x='sentiment', data=mergeddata)
plt.show()
```



Filling the Missing Data to remove null values.

[ ]:

```
from sklearn.base import TransformerMixin

class DataFrameImputer(TransformerMixin):
    def __init__(self):
        """Impute missing values.

        Columns of dtype object are imputed with the most frequent value
        in column.

        Columns of other types are imputed with mean of column.

        """
    def fit(self, X, y=None):
        # Find most common value with value_counts() which returns
        # counts in descending order so that the first element is the most␣
↪frequently-occurring element.
        self.fill = pd.Series([X[c].value_counts().index[0]
            #Use that if type is object otherwise use mean
            if X[c].dtype == np.dtype('O') else X[c].mean() for c in X],
            index=X.columns)

        return self

    def transform(self, X, y=None):
        return X.fillna(self.fill)
```

[ ]:
```
find_missing_value(mergeddata)
```

[ ]:
```
                           column_name  percent_missing
metascore                    metascore        40.845110
price                            price         1.915394
publisher                    publisher         1.594901
developer                    developer         0.864891
release_date_month  release_date_month         0.717937
…                                    …                …
url                                url         0.000000
title                            title         0.000000
app_name                      app_name         0.000000
owned                            owned         0.000000
uid                                uid         0.000000

[19 rows x 2 columns]
```

[ ]:
```
mergeddata = DataFrameImputer().fit_transform(mergeddata)
```

[ ]:
```
find_missing_value(mergeddata)
```

[ ]:
```
                           column_name  percent_missing
uid                                uid              0.0
```

```
reviews_url                reviews_url          0.0
release_date_year    release_date_year          0.0
metascore                    metascore          0.0
sentiment                    sentiment          0.0
…                                    …        …
app_name                      app_name          0.0
genres                          genres          0.0
publisher                    publisher          0.0
owned                            owned          0.0
release_date_month  release_date_month          0.0

[19 rows x 2 columns]
```

```
[ ]: svd_data=mergeddata.copy(deep=True)
```

```
[ ]: mergeddata.head()
```

```
[ ]:    uid  id  owned publisher      genres        app_name           title  \
     0    0  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     1    1  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     2    3  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     3    4  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike
     4   10  10    1.0     Valve  ['Action']  Counter-Strike  Counter-Strike

                                                    url release_date  \
     0  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     1  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     2  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     3  http://store.steampowered.com/app/10/CounterSt…   2000-11-01
     4  http://store.steampowered.com/app/10/CounterSt…   2000-11-01

                                                   tags  \
     0  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…
     1  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…
     2  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…
     3  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…
     4  ['Action', 'FPS', 'Multiplayer', 'Shooter', 'C…

                                            reviews_url  \
     0  http://steamcommunity.com/app/10/reviews/?brow…
     1  http://steamcommunity.com/app/10/reviews/?brow…
     2  http://steamcommunity.com/app/10/reviews/?brow…
     3  http://steamcommunity.com/app/10/reviews/?brow…
     4  http://steamcommunity.com/app/10/reviews/?brow…

                                             specs price  early_access developer  \
     0  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
```

```
1  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
2  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
3  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve
4  ['Multi-player', 'Valve Anti-Cheat enabled']  9.99         False     Valve

  sentiment  metascore  release_date_year  release_date_month
0  Positive       88.0             2000.0                11.0
1  Positive       88.0             2000.0                11.0
2  Positive       88.0             2000.0                11.0
3  Positive       88.0             2000.0                11.0
4  Positive       88.0             2000.0                11.0
```

[ ]:
```
print(mergeddata.select_dtypes(exclude=np.number).columns.tolist)
```

```
<bound method IndexOpsMixin.tolist of Index(['publisher', 'genres', 'app_name',
'title', 'url', 'release_date',
       'tags', 'reviews_url', 'specs', 'price', 'early_access', 'developer',
       'sentiment'],
      dtype='object')>
```

[ ]:
```
import category_encoders as ce

def encode_category_data(dataset_var):
        #We establish the Ordinal encoder which will convert each categorical␣
 ↪label to a number
        # We specify the columns we want to transform, we ask it to handle␣
 ↪missing values if any and also to return a dataframe                    ␣
 ↪instead of an np array
        encode_var = ce.OrdinalEncoder(cols=['publisher', 'genres', 'app_name',␣
 ↪'title', 'url', 'release_date',
        'tags', 'reviews_url', 'specs', 'price', 'early_access', 'developer',
        'sentiment'],handle_missing='return_nan',return_df= True)
        dataset_var=encode_var.fit_transform(dataset_var)
        return dataset_var
```

[ ]:
```
#We now fit the model and transform the data and put it in X which is a␣
 ↪dataframe
mergeddata=encode_category_data(mergeddata)
```

[ ]:
```
mergeddata.sentiment.value_counts()
```

[ ]:
```
1.0    673232
2.0    131330
3.0     15426
Name: sentiment, dtype: int64
```

[ ]:
```
mergeddata.head()
```

```
[ ]:    uid  id  owned  publisher  genres  app_name  title  url  release_date  \
     0    0  10    1.0        1.0     1.0       1.0    1.0  1.0           1.0
     1    1  10    1.0        1.0     1.0       1.0    1.0  1.0           1.0
     2    3  10    1.0        1.0     1.0       1.0    1.0  1.0           1.0
     3    4  10    1.0        1.0     1.0       1.0    1.0  1.0           1.0
     4   10  10    1.0        1.0     1.0       1.0    1.0  1.0           1.0

        tags  reviews_url  specs  price  early_access  developer  sentiment  \
     0   1.0          1.0    1.0    1.0           1.0        1.0        1.0
     1   1.0          1.0    1.0    1.0           1.0        1.0        1.0
     2   1.0          1.0    1.0    1.0           1.0        1.0        1.0
     3   1.0          1.0    1.0    1.0           1.0        1.0        1.0
     4   1.0          1.0    1.0    1.0           1.0        1.0        1.0

        metascore  release_date_year  release_date_month
     0       88.0             2000.0                11.0
     1       88.0             2000.0                11.0
     2       88.0             2000.0                11.0
     3       88.0             2000.0                11.0
     4       88.0             2000.0                11.0
```

Due to hardware Limitation,I am only taking 2Lakh Data for Model

```
[ ]: temp = 200000
     mergeddata=mergeddata[:temp]
```

```
[ ]: mergeddata.sentiment.value_counts()
```

```
[ ]: 1.0    191818
     2.0      5693
     3.0      2489
     Name: sentiment, dtype: int64
```

Choose the Y and x for the Split

```
[ ]: X = mergeddata.iloc[:,mergeddata.columns!='sentiment']
     y = mergeddata.iloc[:,mergeddata.columns=='sentiment']
     print(y.shape)
     print(X.shape)
     del mergeddata
```

```
(200000, 1)
(200000, 18)
```

Apply the K-Fold to split the Test and Train Equally

```
[ ]: from sklearn.model_selection import StratifiedKFold
     variables = StratifiedKFold(n_splits=4)
```

```
for train,test in variables.split(X,y):
    x_train,x_test=X.iloc[train],X.iloc[test]
    y_train,y_test=y.iloc[train],y.iloc[test]
```

[ ]:

```
from sklearn.metrics import accuracy_score, balanced_accuracy_score, f1_score
from sklearn.metrics import␣
 ↪confusion_matrix,plot_confusion_matrix,classification_report
from sklearn.metrics import accuracy_score
from imblearn.over_sampling import SMOTE
from sklearn.preprocessing import Normalizer
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV,RandomizedSearchCV

from sklearn.pipeline import Pipeline
from sklearn.decomposition import PCA
from sklearn import tree
from sklearn import svm
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from surprise import SVD
from surprise import Dataset
from surprise.model_selection import train_test_split,cross_validate
from surprise import Reader ,accuracy
```

[ ]:

```
def␣
 ↪check_standalone_prediction(smote_flag,norm_flag,scale_flag,pca_flag,x_train,y_train,x_test
 ↪
    if smote_flag == True:
        sm=SMOTE(random_state=42)
        x_train, y_train = sm.fit_resample(x_train, y_train)
    if norm_flag == True:
        normalizer = Normalizer(norm='l2')
        x_train = normalizer.fit_transform(x_train)
        x_test = normalizer.fit_transform(x_test)
    if scale_flag == True:
        scaler = StandardScaler()
        x_train=scaler.fit_transform(x_train)
        x_test=scaler.transform(x_test)
    if pca_flag == True:
        pca=PCA(n_components=2)
        x_train = pca.fit_transform(x_train)
        x_test = pca.fit_transform(x_test)

    model_class = model_var.fit(x_train,y_train)
    y_hat=model_class.predict(x_test)

    print(f"Accuracy Score {modelName}: {accuracy_score(y_test,y_hat)}")
    print(f"Confusion Matrix  {modelName}: {confusion_matrix(y_test,y_hat)}")
    print(f"Balanced Accuracy {modelName}:␣
 ↪{balanced_accuracy_score(y_test,y_hat)}")
    print(f"Classification_Report {modelName}:␣
 ↪{classification_report(y_test,y_hat)}")


    print(f"-------------------------------------------------------")
    plot_confusion_matrix(model_var,x_test,y_test)
```

Applying SVD Algorithm

```
[ ]: df_svd= svd_data[['uid', 'id', 'sentiment']].copy()
     del svd_data
```

```
[ ]: encode=ce.
      ↪OrdinalEncoder(cols=['sentiment'],handle_missing='return_nan',return_df=␣
      ↪True)
     df_svd=encode.fit_transform(df_svd)
```

```
[ ]: df_svd.sentiment.value_counts()
```

```
[ ]: 1.0    673232
     2.0    131330
     3.0     15426
     Name: sentiment, dtype: int64
```

```
[ ]: reader=Reader(rating_scale=(1, 3))
     data = Dataset.load_from_df(df_svd[['uid', 'id', 'sentiment']], reader)
```

```
[ ]: svd_train,svd_test=train_test_split(data,test_size=.20)
     model = SVD()
     model.fit(svd_train)
```

```
[ ]: <surprise.prediction_algorithms.matrix_factorization.SVD at 0x247cf8f4fa0>
```

```
[ ]: pred_test=model.test(svd_test)
     accuracy.rmse(pred_test)
```

```
RMSE: 0.0831
```

```
[ ]: 0.08312481239006464
```

```
[ ]: pred=model.predict(15,10)
     pred.est
```

```
[ ]: 1
```

```
[ ]: cross_validate(model,data,cv=5,verbose=True)
```

```
Evaluating RMSE, MAE of algorithm SVD on 5 split(s).

                  Fold 1  Fold 2  Fold 3  Fold 4  Fold 5  Mean    Std
RMSE (testset)    0.0838  0.0853  0.0852  0.0840  0.0849  0.0846  0.0006
MAE (testset)     0.0354  0.0359  0.0360  0.0354  0.0358  0.0357  0.0002
Fit time          28.24   28.60   28.46   28.47   28.47   28.45   0.12
Test time         1.28    1.05    1.08    1.28    1.06    1.15    0.11
```

```
[ ]: {'test_rmse': array([0.08380559, 0.08527449, 0.08518199, 0.08401503,
     0.08487453]),
      'test_mae': array([0.03542969, 0.03594819, 0.03599999, 0.03543335,
     0.03583647]),
      'fit_time': (28.238356113433838,
       28.597787141799927,
       28.458404302597046,
       28.470713138580322,
       28.465381860733032),
      'test_time': (1.2832889556884766,
       1.0502362251281738,
       1.0782546997070312,
       1.2783007621765137,
       1.0552377700805664)}
```

Apply Other Models

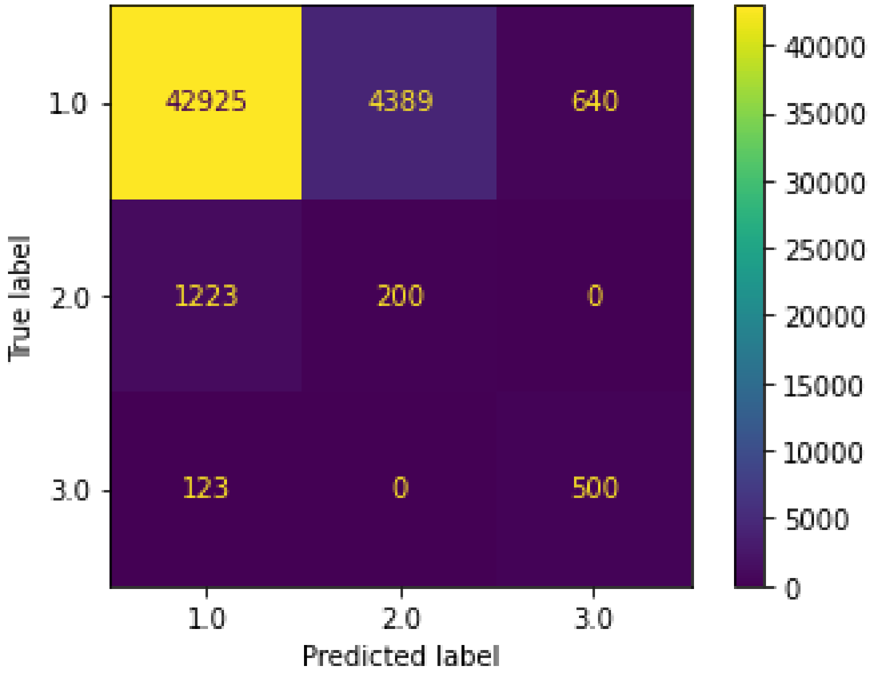
```
[ ]: smote_flag=True
     norm_flag=False
     scale_flag=True
     pca_flag=False
     decision_tree=tree.DecisionTreeClassifier()
     check_standalone_prediction(smote_flag,norm_flag,scale_flag,pca_flag,x_train.
      ↪copy(deep=False),y_train.copy(deep=False),x_test.copy(deep=False),y_test.
      ↪copy(deep=False),decision_tree,"Decision Tree")
```

```
Accuracy Score Decision Tree: 0.8725
Confusion Matrix  Decision Tree: [[42925  4389   640]
 [ 1223   200     0]
 [  123     0   500]]
Balanced Accuracy Decision Tree: 0.6127483403354425
Classification_Report Decision Tree:               precision    recall  f1-score
support

         1.0       0.97      0.90      0.93     47954
         2.0       0.04      0.14      0.07      1423
         3.0       0.44      0.80      0.57       623

    accuracy                           0.87     50000
   macro avg       0.48      0.61      0.52     50000
weighted avg       0.94      0.87      0.90     50000
```

```
-------------------------------------------------------
```



[ ]:
```
smote_flag=True
norm_flag=False
scale_flag=True
pca_flag=False
random_state_class=RandomForestClassifier()
check_standalone_prediction(smote_flag,norm_flag,scale_flag,pca_flag,x_train.
 ↪copy(deep=False),y_train.copy(deep=False),x_test.copy(deep=False),y_test.
 ↪copy(deep=False),random_state_class,"Random Forest Tree")
```

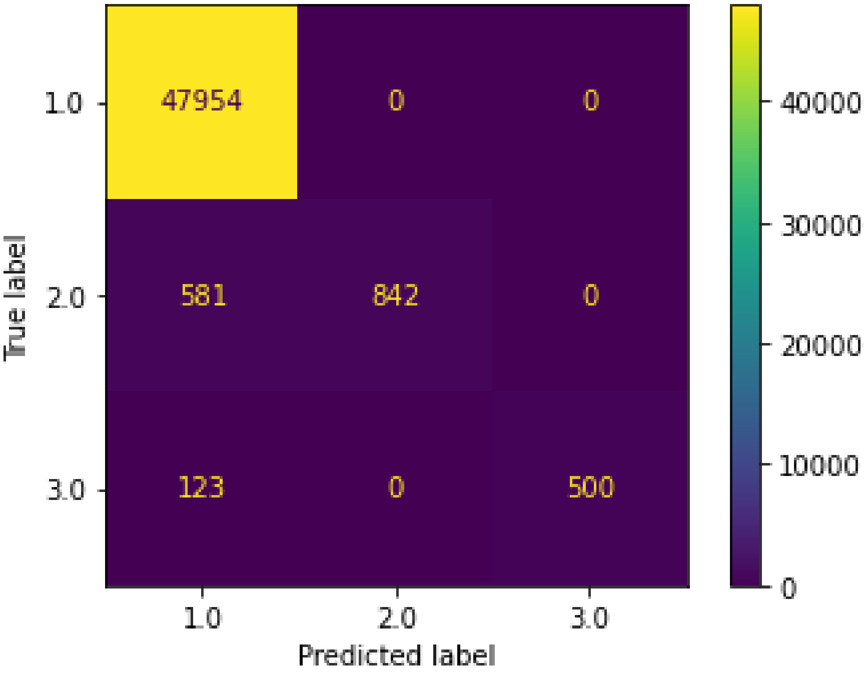
```
<ipython-input-44-29664ce375fa>:18: DataConversionWarning: A column-vector y was
passed when a 1d array was expected. Please change the shape of y to
(n_samples,), for example using ravel().
  model_class = model_var.fit(x_train,y_train)

Accuracy Score Random Forest Tree: 0.98592
Confusion Matrix  Random Forest Tree: [[47954     0     0]
 [  581   842     0]
 [  123     0   500]]
Balanced Accuracy Random Forest Tree: 0.7980919593906873
Classification_Report Random Forest Tree:               precision    recall
f1-score   support

         1.0       0.99      1.00      0.99     47954
         2.0       1.00      0.59      0.74      1423
         3.0       1.00      0.80      0.89       623

    accuracy                           0.99     50000
   macro avg       1.00      0.80      0.88     50000
weighted avg       0.99      0.99      0.98     50000

------------------------------------------------------
```



```
[ ]: smote_flag=True
     norm_flag=False
     scale_flag=False
     pca_flag=True
     knnclassifer = KNeighborsClassifier(n_neighbors=2)
     check_standalone_prediction(smote_flag,norm_flag,scale_flag,pca_flag,x_train.
      ↪copy(deep=False),y_train.copy(deep=False),x_test.copy(deep=False),y_test.
      ↪copy(deep=False),knnclassifer,"Knn Model")
```

```
C:\Users\pmogh\anaconda3\lib\site-
packages\sklearn\neighbors\_classification.py:179: DataConversionWarning: A
column-vector y was passed when a 1d array was expected. Please change the shape
of y to (n_samples,), for example using ravel().
  return self._fit(X, y)
```

```
Accuracy Score Knn Model: 0.91064
Confusion Matrix  Knn Model: [[45532  2422     0]
```

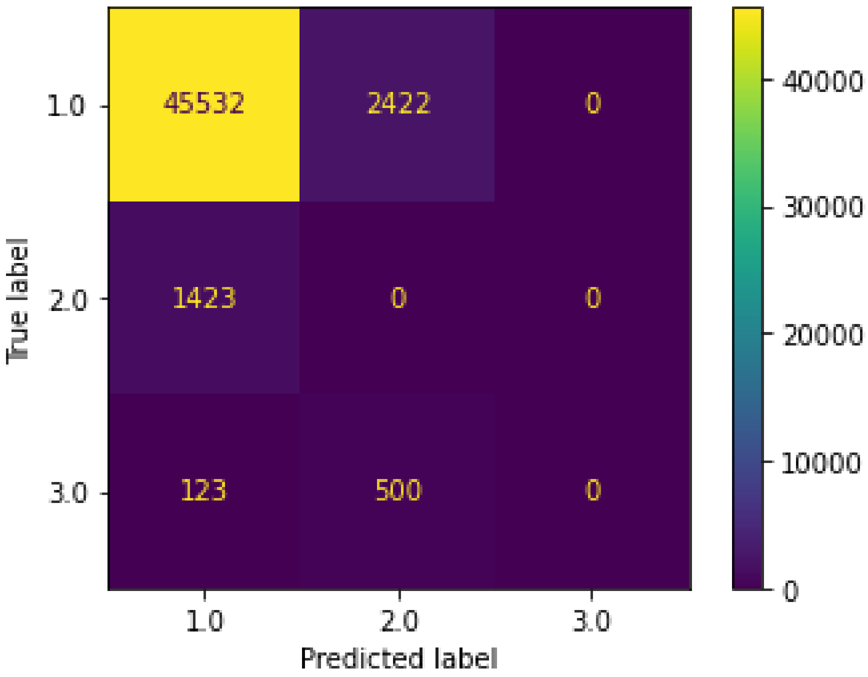
```
 [ 1423     0     0]
 [  123   500     0]]
Balanced Accuracy Knn Model: 0.3164977547927875
Classification_Report Knn Model:               precision    recall  f1-score
support

         1.0       0.97      0.95      0.96     47954
         2.0       0.00      0.00      0.00      1423
         3.0       0.00      0.00      0.00       623

    accuracy                           0.91     50000
   macro avg       0.32      0.32      0.32     50000
weighted avg       0.93      0.91      0.92     50000

------------------------------------------------------

C:\Users\pmogh\anaconda3\lib\site-
packages\sklearn\metrics\_classification.py:1245: UndefinedMetricWarning:
Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\pmogh\anaconda3\lib\site-
packages\sklearn\metrics\_classification.py:1245: UndefinedMetricWarning:
Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\pmogh\anaconda3\lib\site-
packages\sklearn\metrics\_classification.py:1245: UndefinedMetricWarning:
Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```



[ ]:
```
smote_flag=True
norm_flag=False
scale_flag=True
pca_flag=False
svm_class=svm.SVC()
check_standalone_prediction(smote_flag,norm_flag,scale_flag,pca_flag,x_train.
 ↪copy(deep=False),y_train.copy(deep=False),x_test.copy(deep=False),y_test.
 ↪copy(deep=False),svm_class,"SVM Model Tree")
```

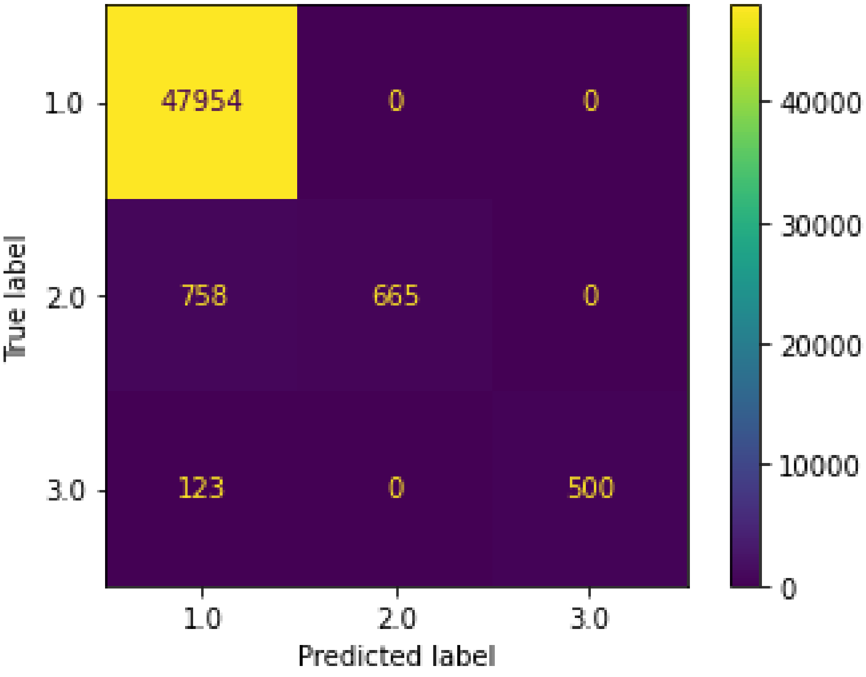
```
C:\Users\pmogh\anaconda3\lib\site-packages\sklearn\utils\validation.py:63:
DataConversionWarning: A column-vector y was passed when a 1d array was
expected. Please change the shape of y to (n_samples, ), for example using
ravel().
  return f(*args, **kwargs)
```

```
Accuracy Score SVM Model Tree: 0.98238
Confusion Matrix  SVM Model Tree: [[47954     0     0]
 [  758   665     0]
 [  123     0   500]]
Balanced Accuracy SVM Model Tree: 0.7566302587582209
Classification_Report SVM Model Tree:               precision    recall
f1-score   support

         1.0       0.98      1.00      0.99     47954
         2.0       1.00      0.47      0.64      1423
         3.0       1.00      0.80      0.89       623
```

```
    accuracy                           0.98     50000
   macro avg       0.99      0.76      0.84     50000
weighted avg       0.98      0.98      0.98     50000

------------------------------------------------------
```



```
[ ]: def hyper_parameter(pipe,param,x_train,y_train,x_test,y_test,model_name):
         rsv=GridSearchCV(pipe,param,cv=10,n_jobs=-1)
         rsv.fit(x_train, y_train)
         score = rsv.score(x_test, y_test)
         y_hat=rsv.predict(x_test)
         print("Score:",score)
         print("Best Param",rsv.best_params_)
         print("Best estimator",rsv.best_estimator_)
         print(f"Accuracy Score {model_name}: {accuracy_score(y_test,y_hat)}")
         print(f"Confusion Matrix  {model_name}: {confusion_matrix(y_test,y_hat)}")
         print(f"Balanced Accuracy {model_name}:␣
      ↪{balanced_accuracy_score(y_test,y_hat)}")
         print(f"Classification_Report {model_name}:␣
      ↪{classification_report(y_test,y_hat)}")

         print(f"------------------------------------------------------")
         plot_confusion_matrix(rsv,x_test,y_test)
```

[ ]:

```
def hyper_parameter_random(pipe,param,x_train,y_train,x_test,y_test,model_name):
    rsv=RandomizedSearchCV(pipe,param,cv=10,n_jobs=-1)
    rsv.fit(x_train, y_train)
    score = rsv.score(x_test, y_test)
    y_hat=rsv.predict(x_test)
    print("Score:",score)
    print("Best Param",rsv.best_params_)
    print("Best estimator",rsv.best_estimator_)
    print(f"Accuracy Score {model_name}: {accuracy_score(y_test,y_hat)}")
    print(f"Confusion Matrix  {model_name}: {confusion_matrix(y_test,y_hat)}")
    print(f"Balanced Accuracy {model_name}:␣
 ↪{balanced_accuracy_score(y_test,y_hat)}")
    print(f"Classification_Report {model_name}:␣
 ↪{classification_report(y_test,y_hat)}")

    print(f"------------------------------------------------------")
    plot_confusion_matrix(rsv,x_test,y_test)
```

[ ]:

```
## Create Copy Of The Test Data
x_train_copy=x_train.copy(deep=False)
y_train_copy=y_train.copy(deep=False)
x_test_copy=x_test.copy(deep=False)
y_test_copy=y_test.copy(deep=False)
## Apply Smote On The Data
sm=SMOTE(random_state=42)
x_train_copy, y_train_copy = sm.fit_resample(x_train_copy, y_train_copy)
#x_test_copy, y_test_copy = sm.fit_resample(x_test_copy, y_test_copy)


params = {"clf__criterion": ['gini', 'entropy'],"clf__max_depth":
 ↪[10,30,50,100,None]}

pipe = Pipeline(steps=[('transformer',StandardScaler()),("clf", tree.
 ↪DecisionTreeClassifier())])
#pca 86
#without pca 99
hyper_parameter(pipe,params,x_train_copy,y_train_copy,x_test_copy,y_test_copy,"Decision␣
 ↪Tree")
del x_train_copy
del y_train_copy
del x_test_copy
del y_test_copy

del params
del pipe
```

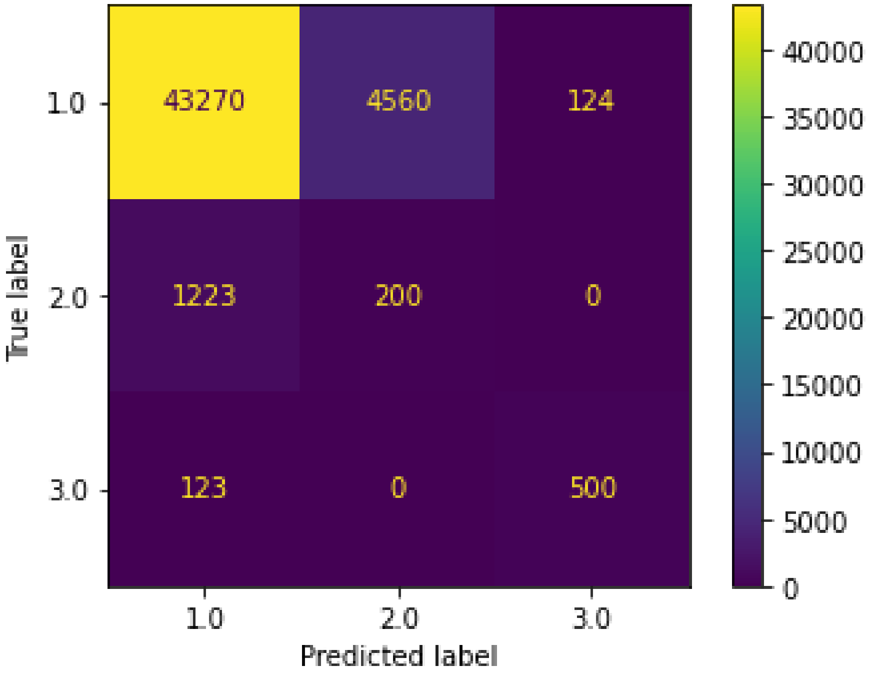
```
Score: 0.8794
```

```
Best Param {'clf__criterion': 'gini', 'clf__max_depth': 10}
Best estimator Pipeline(steps=[('transformer', StandardScaler()),
                ('clf', DecisionTreeClassifier(max_depth=10))])
Accuracy Score Decision Tree: 0.8794
Confusion Matrix  Decision Tree: [[43270  4560   124]
 [ 1223   200     0]
 [  123     0   500]]
Balanced Accuracy Decision Tree: 0.6151464718781708
Classification_Report Decision Tree:               precision    recall  f1-score
support

         1.0       0.97      0.90      0.93     47954
         2.0       0.04      0.14      0.06      1423
         3.0       0.80      0.80      0.80       623

    accuracy                           0.88     50000
   macro avg       0.60      0.62      0.60     50000
weighted avg       0.94      0.88      0.91     50000

------------------------------------------------------
```



[ ]:
```
## Create Copy Of The Test Data
x_train_copy=x_train.copy(deep=False)
y_train_copy=y_train.copy(deep=False)
x_test_copy=x_test.copy(deep=False)
```

```
y_test_copy=y_test.copy(deep=False)
## Apply Smote On The Data
sm=SMOTE(random_state=42)
x_train_copy, y_train_copy = sm.fit_resample(x_train_copy, y_train_copy)
#x_test_copy, y_test_copy = sm.fit_resample(x_test_copy, y_test_copy)

params = {"clf__n_estimators": [10,30,50,100],"clf__max_depth":␣
 ↪[10,50,None],"clf__max_features": [5, 10],"clf__bootstrap":
 ↪[True,False],"clf__criterion":['gini','entropy']}

pipe = Pipeline(steps=[("transformer", StandardScaler()),("clf",␣
 ↪RandomForestClassifier())])

hyper_parameter_random(pipe,params,x_train_copy,y_train_copy,x_test_copy,y_test_copy,"Random␣
 ↪Forest")
del x_train_copy
del y_train_copy
del x_test_copy
del y_test_copy

del params
del pipe
```

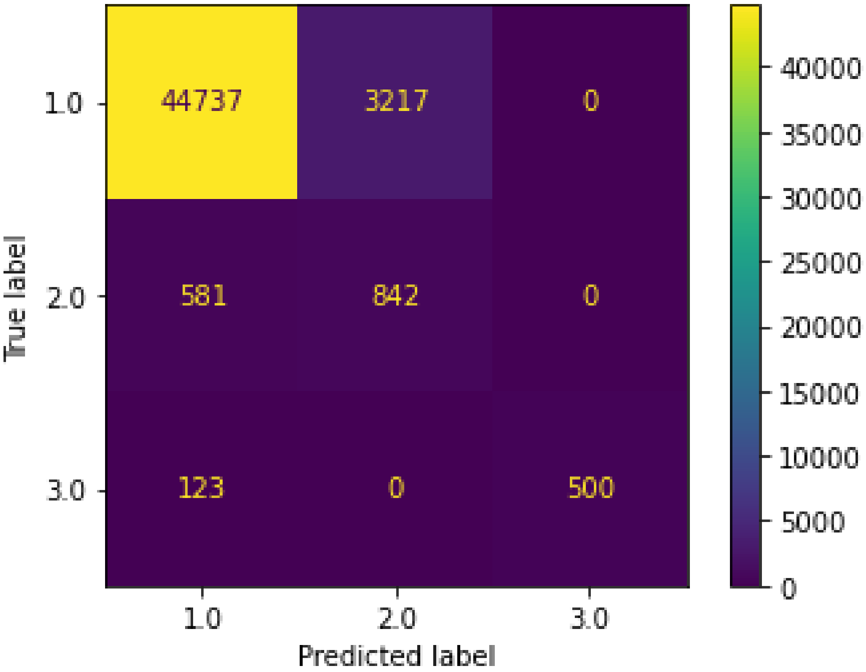
```
C:\Users\pmogh\anaconda3\lib\site-packages\sklearn\pipeline.py:346:
DataConversionWarning: A column-vector y was passed when a 1d array was
expected. Please change the shape of y to (n_samples,), for example using
ravel().
  self._final_estimator.fit(Xt, y, **fit_params_last_step)
```

```
Score: 0.92158
Best Param {'clf__n_estimators': 10, 'clf__max_features': 10, 'clf__max_depth':
10, 'clf__criterion': 'entropy', 'clf__bootstrap': False}
Best estimator Pipeline(steps=[('transformer', StandardScaler()),
                ('clf',
                 RandomForestClassifier(bootstrap=False, criterion='entropy',
                                        max_depth=10, max_features=10,
                                        n_estimators=10))])
Accuracy Score Random Forest: 0.92158
Confusion Matrix  Random Forest: [[44737  3217     0]
 [  581   842     0]
 [  123     0   500]]
Balanced Accuracy Random Forest: 0.7757302516429846
Classification_Report Random Forest:               precision    recall  f1-score
support

         1.0       0.98      0.93      0.96     47954
         2.0       0.21      0.59      0.31      1423
         3.0       1.00      0.80      0.89       623
```

```
    accuracy                           0.92     50000
   macro avg       0.73      0.78      0.72     50000
weighted avg       0.96      0.92      0.94     50000

------------------------------------------------------
```


True label
Predicted label